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September 25, 2000

BOX PATENT APPLICATION
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Derrick T. Gordon

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September 25, 2000

Date of Signature

Re: New U.S. Patent Application
DIGITAL CAMERA AND EXPOSURE CONTROL METHOD
OF DIGITAL CAMERA
By: Hiroaki KUBO
Attorney Docket: 15162/02540

Dear Sir:

Enclosed for filing are the following papers relating to
DIGITAL CAMERA AND EXPOSURE CONTROL METHOD OF DIGITAL CAMERA,
Hiroaki KUBO, inventor:

- (1) Specification (31 pages, including 14 claims and an abstract);
- (2) Executed Declaration and Power of Attorney (6 pages);
- (3) Formal Drawings (8 sheets);
- (4) Transmittal letter (2 pages) with PrintEFS Patent Application Bibliographic Data (1 page);

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- (5) Transmittal letter (2 pages) with certified copy of priority document (33 pages);
- (6) Information Disclosure Statement (2 pages) with attached PTO-1449 form (1 page) and copies of the 5 cited references; and
- (7) Assignment (2 pages) of the invention to MINOLTA CO., LTD., with attached Recordation Form Cover Sheet (1 page) (in duplicate).

The amount of the filing fee is calculated below:

			Fee for small entity			Fee for other than small entity	
Fee	No. filed	No. extra *	Rate	Fee	OR	Rate	Fee
Basic fee				\$345	OR		\$690
Total claims	14-20=	0	X \$9=	\$0	OR	X \$18=	\$-0-
Independent claims	6-3=	3	X \$39=	\$0	OR	X \$78=	\$234
Multiple Dependent Claim Presented	0	0	+\$130=	\$0	OR	+\$260=	\$-0-
			Total	\$0	OR	Total	\$924.00

*If the difference in Column 1 is less than zero, enter "0" in Column 2.

Please charge the required fees (\$924.00 for the application filing fee and \$40.00 for recordal of the Assignment) to Sidley & Austin's Deposit Account No. 18-1260. If additional fees are due, please charge any fees required during the pendency of this application (other than the issue fee) to Deposit Account No. 18-1260. Please credit any overpayment to Deposit Account No. 18-1260.

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DALLAS

Assistant Director For Patents
September 25, 2000
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This transmittal letter is being filed in duplicate.

All correspondence is to be directed to the Applicant's attorney at the Dallas address listed above.

Respectfully submitted,

By: James W. Williams
James W. Williams
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JWW:pm
Enclosures

Attorney Docket No. 15162/02540

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re

U.S. application of: Hiroaki KUBO
For: DIGITAL CAMERA AND EXPOSURE
CONTROL METHOD OF DIGITAL CAMERA
U.S. Serial No.: To Be Assigned
Filed: Concurrently
Group Art Unit: To Be Assigned
Examiner: To Be Assigned

BOX PATENT APPLICATION
Assistant Director
for Patents
Washington, D.C. 20231

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Patents, Washington, DC 20231

Derrick T. Gordon

Name of Person Mailing Paper or Fee

Derrick T. Gordon

Signature

September 25, 2000

Date of Signature

Dear Sir:

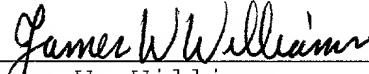
TRANSMITTAL OF PrintEFS PATENT APPLICATION

BIBLIOGRAPHIC DATA

Submitted herewith is bibliographic data (1 page) for
the above-identified application, in the PrintEFS Version
1.0.1 program format.

Attorney Docket No. 15162/02540

Respectfully submitted,



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Registration No. 20,047
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APPLICATION INFORMATION

Title Line One:: DIGITAL CAMERA AND EXPOSURE CONTROL METH
Title Line Two:: OD OF DIGITAL CAMERA
Total Drawing Sheets:: 8
Formal Drawings?: Yes
Application Type:: Utility
Docket Number:: 15162/02540
Secrecy Order in Parent Appl.?: No

REPRESENTATIVE INFORMATION

Representative Customer Number:: 24367

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Foreign Application One:: 11-274400
Filing Date:: 09-28-1999
Country:: JAPAN
Priority Claimed:: Yes

Source:: PrintEFS Version 1.0.1

DIGITAL CAMERA AND EXPOSURE CONTROL METHOD OF DIGITAL CAMERA

This application is based on the application No. 11-
5 274400 filed in Japan, the content of which is hereby
incorporated by reference.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

10 The present invention relates to a camera such as a digital
camera and a silver halide film camera for shooting a subject,
and more particularly, to setting of shooting conditions.

DESCRIPTION OF THE RELATED ART

15 A camera has previously been known in which the aperture
value Av and the exposure time (shutter speed) Tv which are
exposure conditions are set by the user when shooting is
performed. Moreover, a camera has previously been known in
which in order to reduce the load of setting on the user, the
20 aperture value Av and the exposure time Tv previously obtained
by use of a relationship $Ev=Av+Tv$ for each of the exposure
amounts Ev corresponding to subject brightnesses obtained by
photometric means are provided in the form of a table (a program
line), and the aperture value Av and the exposure value Tv are
25 automatically set from the obtained exposure amount Ev . In

recent years, a camera having a plurality of such program lines has been known.

However, in a case where the exposure conditions are set based on the subject brightness or the like, the shot image is blurred when the subject moves by some amounts. Moreover, in a camera provided with a plurality of program lines, there is a possibility that a good moment to take a picture is missed because of an operation to select an appropriate program line. Further, it is not ensured that an appropriate program line is selected when the subject is moving. Therefore, with these cameras, it is impossible to perform appropriate shooting unless the user has some experience in shooting.

The present invention is made in view of the above-mentioned problem, and an object thereof is to provide a digital camera in which a relative positional displacement (blur) between the subject and the camera can be minimized by automatically setting appropriate exposure conditions according to the movement of the subject.

SUMMARY OF THE INVENTION

To achieve the above-mentioned object, a digital camera according to the present invention comprises: an image sensing unit for sensing a subject image; a detector for detecting a degree of correlation between image data of a plurality of frames from said image sensing unit before shooting; an exposure

controller for, in a case where the degree of correlation is low as a result of the detection by said detector, controlling an exposure time of said image sensing unit so as to be shorter than an exposure time in a case where the degree of correlation is high; and a recorder for recording image data from said image
5 sensing unit controlled by said exposure controller.

Further, as another invention for achieving the above-mentioned object, a digital camera comprises: an image sensing unit for sensing a subject image; a detector for
10 detecting a degree of correlation between image data of a plurality of frames from said image sensing unit before shooting; a memory for storing a first program and a second program to control an exposure time of said image sensing unit respectively, wherein the exposure time based on the second
15 program is set to be shorter than the exposure time based on the first program; a selector for selecting the second program in the case where the degree of correlation is lower than a predetermined level; and a recorder for recording image data from said image sensing unit controlled based on the second
20 program.

Further, as another invention for achieving the above-mentioned object, a digital camera comprises: an image sensing unit for sensing a subject image; a detector for
detecting a degree of correlation between image data of a
25 plurality of frames from said image sensing unit before

shooting; a memory for storing a first program and a second program to control an aperture value of said image sensing unit respectively, wherein the aperture value based on the second program is set to be smaller than the aperture value based on the first program; a selector for selecting the second program in the case where the degree of correlation is lower than a predetermined level; and a recorder for recording image data from said image sensing unit controlled based on the second program.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following description, like parts are designated by like reference numbers throughout the several drawings.

FIG. 1 is a block diagram showing a control configuration of a digital camera according to an embodiment of the present invention;

FIG. 2 is a block diagram of a calculation of exposure control values in the digital camera of FIG. 1;

FIG. 3A is a view showing image data of a subject whose movement is comparatively small;

FIG. 3B is a view showing interframe non-correlated portion data corresponding to the image data of FIG. 3A;

FIG. 4A is a view showing image data of a subject whose movement is comparatively large;

FIG. 4B is a view showing interframe non-correlated

portion data for the image data of FIG. 4A;

FIG. 4C is a view showing an image blurred because of exposure in accordance with a standard program line;

FIG. 5 is a view showing program lines for an exposure
5 value Ev;

FIG. 6 is a flowchart showing an operation of the digital camera of FIG. 1;

FIG. 7 is a flowchart detailing an exposure control value setting processing of FIG. 6; and

10 FIG. 8 is a view showing programs selected based on a non-correlated area.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a block diagram showing an embodiment of a
15 control configuration of a digital camera according to the present invention. In FIG. 1, the digital camera 1 comprises: a camera control section (CPU) 2 for controlling shooting in accordance with a shooting control program stored in a data storage section 21; an operation switch 3; an imaging section
20 4 for forming a subject light image; a diaphragm driver 5 for controlling the aperture of a diaphragm 51 interposed on the optical axis L; a timing generator and sensor driver 6 (hereinafter, abbreviated as driver 6) for controlling the exposure time and charge transfer; an analog signal processing
25 section 7; an image memory 8 serving as a work memory; a digital

image processing section 9; and a monitor 10 such as a liquid crystal display. A memory card 11 is designed so as to be detachably attachable to a camera body 12, and has a capacity sufficient for storing image data corresponding to a plurality of frames.

The operation switch 3 has a power switch, an S1 switch for providing an instruction to make shooting preparations, and an S2 switch for providing an instruction to release the shutter (perform shooting). The S1 switch is turned on by half depressing the shutter button. The S2 switch is turned on by fully depressing the shutter button.

The imaging section 4 comprises: solid-state image sensing devices (light receiving section) arranged in a matrix; and a charge transfer section. Moreover, the imaging section 4 is a single-plate area sensor, and on the front surface of a light receiving surface where a subject light image is formed through a taking lens 41, transparent filters of three primary colors are arranged, for example, checkerwise in pixel units.

The diaphragm driver 5 adjusts the aperture of the diaphragm 51 in accordance with the aperture value obtained by the camera control section 2 as described later.

The driver 6 controls charge integration, charge reading and transfer and the like performed on the imaging section 4, in accordance with an instruction from the camera control section 2. In a preview mode (standby mode) before shooting,

the driver 6 causes the imaging section 4 to perform shooting every 1/30 second. At the time of shutter release (shooting), the driver 6 causes the imaging section 4 to perform shooting with the exposure time set by the camera control section 2 as described later.

The analog signal processing section 7 comprises a CDS circuit 71, an AGC circuit 72 and an A/D conversion circuit 73. The analog signal processing section 7 performs a predetermined signal processing on an analog image signal output from the imaging section 4 and then, converts the analog image signal into a digital signal. That is, the CDS circuit 71 reduces reset noise included in the analog image signal. The AGC circuit 72 normalizes the analog image signal by level-correcting (sensitivity-correcting) it. The A/D conversion circuit 73 converts the analog image signal normalized by the AGC circuit 72 into a digital image signal of predetermined bits, for example, 10 bits (hereinafter, this image signal will be referred to as frame image data).

The image memory 8 has a storage capacity corresponding at least to the number of light receiving devices of the imaging section 4. In the image memory 8, the frame image data output from the A/D conversion circuit 73 and the frame image data processed by the digital image processing section 9 are temporarily stored. While it is preferable for the image memory 8 to have a storage capacity corresponding to two frames, the

image memory 8 may have a storage capacity corresponding to one frame. When the image memory 8 has a storage capacity corresponding to one frame, the level difference can be extracted by obtaining the difference between the already
5 stored first frame and the second frame in real time.

The digital image processing section 9 performs predetermined signal processing on the frame image data temporarily stored in the image memory 8.

A pixel interpolation section 91 improves resolution by
10 interpolating pixel data between pixel positions of each of red (R), green (G) and blue (B) components. In this embodiment, a CCD area sensor in which pixels corresponding to R, G and B are arranged checkerwise is used as the imaging section 4. Therefore, the frame image of each color is formed as a group
15 of pixel data at pixels arranged in pixel positions other than the pixel positions of the other two colors. For this reason, the image interpolation section 91 interpolates data between pixel data by use of the pixel data obtained at each pixel. To interpolate pixel data, for the frame image of, for example,
20 the G component, masking of the image data constituting the frame image is performed by use of a predetermined filter pattern, and then, using a median filter, the average value of the pixel data remaining when the maximum and the minimum values are removed from the pixel data in the vicinity of a position
25 to be interpolated (peripheral four pixels) is obtained as the

pixel data of the position. For the R and the B components,
interpolation is performed with the average value of the image
data of the peripheral four pixels. Then, the camera control
section 2 again stores in the image memory 8 the frame images
5 of the color components having undergone the pixel
interpolation.

A color balance control section 92 reads the interpolated
image data of the colors from the image memory 8, and
level-corrects (gain-corrects) the image data of the colors
10 based on adjustment data set by the camera control section 2,
thereby making white balance correction of R, G and B. In the
white balance correction, a part of the shot subject that is
considered to be white is conjectured from brightness and chroma
data, the G-to-R ratio and the G-to-B ratio are obtained from
15 the average value of each of R, G and B of the part, and a
correction calculation is performed with the values of the
ratios as correction gains of R and B. The corrected image data
is again stored in the image memory 8 by the camera control
section 2.

20 A gamma correction section 93 non-linearly converts the
level of the image data read from the image memory 8 for each
color component by use of a predetermined gamma characteristic,
and corrects the white-balance-adjusted image data so as to be
suitable for the tone characteristic of the monitor 10, a
25 monitor for external output, a printer (not shown) or the like.

The converted image data is again stored in the image memory 8 by the camera control section 2.

An image compression and decompression section 94 compresses for recording the gamma-corrected image data read from the image memory 8, for example, according to JPEG. Moreover, the image compression and decompression section 94 decompresses the compressed image data when the image data is reproduced. A video encoder 95 converts image data into one being compliant with the scanning system of the monitor 10, for example, the NTSC system or the PAL system. A memory card driver 96 controls writing and reading of compressed image data onto and from the memory card 11.

FIG. 2 is a block diagram of a calculation of exposure control values in the digital camera of FIG. 1. In FIG. 2, a non-correlation determination section 97 is provided in the digital image processing section 9, and comprises: a resolution conversion section 971; an interframe difference calculation section 972 as correlated portion detection means; a threshold value comparison section 973; and a non-correlated portion area calculation section 974 as area calculation means.

To reduce the load of correlation processing, the resolution conversion section 971 converts the resolutions of the current (this time) frame image and the previous (last time) frame image captured in the image memory 8 during shooting standby so that the number of pixels constituting the frame

images are reduced.

The interframe difference calculation section 972 obtains the level data difference for each corresponding pixels in the current and the previous frame images whose number of pixels has been reduced. In this embodiment, the level data difference is obtained by subtracting the level data of the previous frame image from the level data of the current frame image.

The threshold value comparison section 973 compares the level values of the non-correlated portions (different portions) of the difference-obtained frame images with predetermined threshold value data, removes the non-correlated portions (different portions) whose level values are not more than the predetermined threshold value, and then, extracts the non-correlated portions based on which the subject is judged to move between the frames. Although various comparison methods are considered, in this embodiment, the level data of the previous frame image is subtracted from the level data of the current frame image, and comparison is performed only when the result of the subtraction is a positive value.

Alternatively, comparison may be performed when the difference between the level data of the current frame image and the level data of the previous frame image is a negative value, or comparison may be performed irrespective of whether the difference is a positive value or a negative value. In this

case, half the obtained number of pixels (corresponding to the area in this embodiment as mentioned later) is treated as the object of evaluation.

5 The non-correlated portion area calculation section 974 calculates the area of the non-correlated portions, and obtains the ratio of the area of the non-correlated portion to all the detected pixels (non-correlated area ratio). This is equivalent to the ratio between the sum of the pixels of the non-correlated portions and the total number of detected
10 pixels.

An exposure calculation block 22 is provided in the camera control section 2, and outputs the threshold value data to the threshold value comparison section 973 in accordance with the exposure level (contrast) of the current frame image from the resolution conversion section 971. Moreover, the exposure
15 calculation block 22 selects an appropriate program line from among a plurality of program lines in accordance with the non-correlated area ratio supplied from the non-correlated portion area calculation section 974, and sets the exposure
20 control values (the aperture value and the exposure time) at the time of shutter release (shooting) by use of the selected program line.

The camera control section 2 comprises: the data storage section 21 in which a plurality of program lines (P1 to P3 in
25 this embodiment) in addition to a shooting control program are

stored; and the exposure calculation block 22. In each of the program lines, a relationship between the exposure time and the aperture value corresponding to an exposure amount is preset.

A program line selecting processing will be detailed.

5 FIG. 8 shows programs, to be selected (adopted), suitable for the non-correlated area ratio outputs (area ratio outputs of the moving part of a subject) or the like.

In FIG. 8, as the program lines, a standard program line P1, a focus depth priority program line P2 in which the aperture
10 is smaller than that of the standard program line P1, and a speed priority program line P3 in which the exposure time is set to be shorter than that of the standard program line P1 are provided as shown in FIG. 5. In a case where the non-correlated area ratio between the current and the previous frame images is less
15 than five percent, when the subject brightness is normal (not less than a predetermined brightness), the focus depth priority program line P2 is selected, and when the subject brightness is low (less than the predetermined brightness), the standard program line P1 is selected. In a case where the non-correlated
20 area ratio is not less than five percent and less than 20 percent, the standard program line P1 is selected irrespective of the subject brightness. In a case where the non-correlated area ratio is not less than 20 percent, when the subject brightness is normal, the speed priority program line P3 is selected, and
25 when the subject brightness is low, the standard program line

P1 is selected.

When the subject brightness is low in the case where the non-correlated area ratio is less than five percent, the standard program line P1 is adopted because if the focus depth priority program line P2 is selected, the exposure time increases and this can cause a camera shake. Therefore, the standard program line P1 is adopted in order to prevent the occurrence of a camera shake as much as possible. Moreover, when the subject brightness is low in the case where the non-correlated area ratio is not less than 20 percent, the standard program line P1 is adopted because if the speed priority program line P3 is selected, an appropriate aperture value cannot be set and this results in underexposure. Therefore, the standard program line P1 is adopted in order to prevent this.

FIGs. 3A and 3B show shot images of a subject and non-correlated portion data (the black parts) in a case where the movement of the subject is comparatively small, respectively. In FIG. 3A, images are shot at predetermined intervals like the images 1 to 3, and for example, the difference between the image 2 and the image 1 is obtained to thereby obtain non-correlated portion data B1. When the S1 switch is depressed after the image 3 is captured, the difference between the image 3 and the image 2 is obtained to thereby obtain non-correlated portion data B2. When it is determined that the area ratio of

the non-correlated portion data B2 is less than five percent,
it is determined that the movement of the subject relative to
the camera is also small, so that the focus depth priority
program line P2 is selected. Consequently, the aperture value
5 is set to be higher than the aperture value in a normal operation
state (in a case where the standard program line P1 is selected).
This increases the depth of focus. Even though the exposure
time increases as the aperture decreases, since the movement
of the subject is small, problems do not readily arise such that
10 it is difficult to focus the camera on the subject and that a
camera shake is apt to occur. When the S2 switch is depressed
under this state, a shot image of the subject in which there
is no blur like the image 4 is recorded. When the subject
brightness is low, the standard program line P1 is adopted for
15 the above-mentioned reason.

A case where the movement of the subject is comparatively
large will be described with reference to FIGs. 4A to 4C. FIGs.
4A, 4B and 4C show shot images of a subject, non-correlated
portion data (the black part) and an image shot by use of a
20 program exposure employing the standard program line P1 (the
image 4), respectively. In FIG. 4A, images are shot at
predetermined intervals like the images 1 and 2 (preceding
images are not shown). For example, it is assumed that the
difference between the image 2 and the image 1 is obtained to
25 thereby obtain non-correlated portion data B11. When the S1

switch is depressed while the image 2 of FIG. 4A is being captured, the degree of correlation is evaluated for the non-correlated portion data B11 obtained from the difference between the image 2 and the image 1.

5 When it is determined that the area ratio of the non-correlated portion data B11 is not less than 20 percent, it is determined that the movement of the subject is large, so that the speed priority program line P3 is selected. Therefore, when an instruction to release the shutter is provided here, the
10 speed priority program line P3 is adopted, so that the exposure time is set to be shorter than the normal exposure time. Consequently, even when the movement of the subject is somewhat fast, the shot image of the subject does not readily blur as shown in the image 3 of FIG. 4A.

15 On the contrary, when an instruction to release the shutter is provided under the standard program line P1 in the case where the area ratio of the non-correlated portion data B11 is not less than 20 percent, as shown in the image 4 of FIG. 4C, the shot image of the subject blurs because the movement
20 of the subject is fast, so that an unsharp image is obtained.

 When the area ratio of the non-correlated portion data B11 is not less than 5 percent and less than 20 percent (when the condition of the subject movement is normal), the standard program line P1 is selected as the appropriate program line.

25 FIG. 6 is a flowchart showing an example of an operation

of the digital camera shown in FIG. 1. As shown in FIG. 6, when the shooting mode is selected with the power switch (not shown) on (#1), the aperture of the diaphragm 51 is controlled so as to be maximum at step #3, so that the digital camera is brought
5 into a preview state.

When shooting is performed with a predetermined exposure time (charge integration time) at step #5 and shooting is finished, data reading and data transfer are performed at step #7. Then, at step #9, calculations of photometric measurement
10 of the subject brightness (for exposure control), colorimetric measurement (for WB control) and distance measurement (for AF control) are performed. Then, at step #11, based on the results of the calculations at step #9, AE (exposure control value) in accordance with the normal program line P1, WB (white balance),
15 gain and AF (autofocus) are set. Then, after predetermined signal processings such as white balance adjustment and gamma correction are performed on the shot image at step #13, the processed frame image is shown for preview on the monitor 10 through the video encoder 95 (the frame image is shown as a moving
20 image) (step #15).

Then, whether the S1 switch is on or not is determined at step #17. When the S1 switch is not on, the process returns to step #5, and steps #5 to #15 are repeated. When the S1 switch is on at step #17, the values of AWB and AF are locked (step
25 #19), and the exposure amount Ev obtained immediately before

the S1 switch is turned on and the exposure control values (the aperture value and the exposure time) are decided (step #21). The processing to decide the exposure control values will be described later. On the monitor 10, the image shot immediately
5 before the S1 switch is turned on is fixedly displayed.

Then, whether the S2 switch (release switch) is on or not is determined (step #23). When the S2 switch is not on, whether the S1 switch continues being on for a predetermined time or not is determined (step #25). When the S1 switch continues
10 being on within the predetermined time, the current state is maintained. When the S1 switch continues being on for not less than the predetermined time, it is determined that the user has no intention to perform shooting, and the process returns to step #5. When the S2 switch is on at step #23, at step #27,
15 the imaging section 4 is reset, charge integration is performed for the set exposure time and then, the integrated charge is transferred (end of exposure). That is, based on the aperture value (aperture amount) of the diaphragm 51 and the exposure time set in accordance with the selected program line (step #21),
20 shooting of the subject (real exposure) is performed by the imaging section 4.

Then, the image data is read at step #29. The read image data undergoes predetermined signal processings such as pixel interpolation, color balance adjustment, gamma correction and
25 image compression at the analog signal processing section 7 and

the digital image processing section 9 (step #31), and is then stored in the image memory 8. Then, the processed image is displayed as a still image on the monitor 10 (step #33) and is also recorded onto the memory card 11 by the memory card driver 96 (step #35).

Then, the diaphragm 51 is returned to the maximum aperture state through the diaphragm driver 5, and image capture is performed under this state.

In the reproduction mode, the compressed data recorded on the memory card 11 is read out into the image compression and decompression section 94 through the memory card driver 96, and the data is decompressed into the original image data. Then, the image data is converted into a video signal of a scanning format supported by the video encoder 95 and is displayed on the monitor 10. By turning off the power switch 3, shooting is finished.

FIG. 7 is a flowchart explaining the exposure control value setting processing of FIG. 6 (#21). As shown in FIG. 7, first, at step #41, the current frame image and the previous frame image are resolution-converted to thereby reduce the number of pixels. Then, at step #43, the level data difference is obtained for each corresponding pixels of these frames to thereby extract an interframe non-correlated portion. Then, the extracted data is compared with a threshold value at step #45 and the data of a level not less than the threshold value

level is extracted as a non-correlated portion (portion with no correlation), and then, the ratio of the area of the non-correlated portion to all the detected pixels is obtained at step #47.

5 Then, whether the non-correlated portion area ratio is less than five percent or not is determined at step #49. When the non-correlated portion area ratio is less than five percent (YES), whether the subject brightness is not less than the normal brightness (predetermined brightness) or not is
10 determined at step #51. When the subject brightness is not less than the normal brightness (YES), it is determined that the subject is stationary, so that the focus depth priority program line P2 is selected at step #53. When the subject brightness is less than the normal brightness (NO, low brightness) at step
15 #51, the standard program line P1 is selected at step #55.

 When the non-correlated portion area ratio is not less than five percent (NO) at step #49, whether the non-correlated area ratio is less than 20 percent or not is determined at step #57. When the non-correlated area ratio is not less than five
20 percent and less than 20 percent (YES), it is determined that the speed of the subject movement is normal, and the normal program line P1 is selected in either of the cases of normal brightness and low brightness (step #55). When the non-correlated area ratio is not less than 20 percent (NO) at step
25 #57, it is determined that the speed of the subject movement

is faster than the normal speed. Then, whether the subject brightness is not less than the normal brightness or not is determined at step #59. When the subject brightness is higher than the normal brightness (YES), the speed priority program
5 line P3 is selected at step #61. When the subject brightness is lower than the normal brightness (NO) at step #59, to prevent underexposure, the normal program lines P1 is selected at step #55.

Then, at step #63, the exposure control values (the
10 aperture value and the exposure time) are set based on an appropriate program line selected in accordance with the magnitude of the subject movement (the magnitude of the area ratio).

As described above, when the speed of the subject movement
15 is fast, it is determined that a blurred picture is likely to be obtained with the aperture value and the exposure time of the normal operation state, so that exposure is performed at high speed in accordance with the speed priority program line P3. When the speed of the subject movement is low, image blur
20 does not readily occur even when exposure is performed at low speed in accordance with the focus depth priority program line P2, and since the aperture is reduced, the depth of field is large, so that a plurality of subjects is easily in focus as a whole. In any case, most suitable exposure with few blurs
25 can be realized. Since the normal program line P1 is selected

to avoid underexposure when the subject brightness is low, appropriate exposure control values corresponding to the subject movement can be automatically set.

In this embodiment, the non-correlated portion area calculation section 974 is structured so as to calculate the area of the non-correlated portion and obtain the ratio (non-correlated area ratio) of the area of the non-correlated portion to all the detected pixels. However, the section 974 may be structured so as to calculate the number of pixels of the non-correlated portion obtained by the interframe difference calculation section 972 and decide the degree of image correlation based on the number of pixels. Moreover, the section 974 may be structured so as to decide the degree of image correlation based on the area (not the area ratio) corresponding to the number of pixels of the non-correlated portion. Further, the section 974 may be structured so as to decide the degree of image correlation based on the area ratio to a predetermined area smaller than the total area.

Moreover, in this embodiment, to evaluate the degree of the subject movement, the interframe difference is obtained for each corresponding pixels, an interframe non-correlated portion is extracted and the ratio of the area of the non-correlated portion is obtained. However, a correlated portion may be extracted to obtain the ratio of the area of the correlated portion. In this case, the higher the ratio of the area of the

correlated portion is, the slower (smaller) the subject movement is.

Further, in this embodiment, the subject movement condition is determined among the following three: a moving
5 condition in which the movement is fast (vigorous); a moving condition in which the movement is normal; and a stationary condition in which the movement is slow (small), and the exposure control values are set based on the result of the determination. However, the present invention is not limited
10 thereto. The subject movement condition may be determined between two conditions of a moving condition and a stationary condition, or may be determined among four or more movement conditions. The exposure control values may be set in accordance with the result of the determination. In this case,
15 program lines corresponding to the number of movement conditions are provided.

As the method of setting the exposure control values for the subject movement condition, instead of storing a plurality of program lines, coefficients for a standard program line may
20 be provided in a storage section so that the exposure control values (the exposure time and the aperture value) are obtained by multiplying the standard program line by the corresponding coefficient in accordance with the result of detection of the correlation ratio.

25 The present invention enables a relative positional

displacement (blur) between the subject and the camera to be minimized as a consequence in addition to the degree of subject movement.

As described above, according to this embodiment, the
5 degree of correlation between shot subject images is evaluated and based on the result of the evaluation, an appropriate exposure time corresponding to the subject movement is automatically set. Consequently, subject image blur can be minimized.

10 Moreover, according to this embodiment, since the degree of correlation can be evaluated from the entire area of a subject image (that is, the frame image), the precision of the evaluation can be increased.

Moreover, according to this embodiment, by detecting a
15 correlated portion (or a non-correlated portion) of subject images, the subject movement condition can be easily and precisely determined. Further, since the degree of correlation can be evaluated only by using the difference between level data which is pixel data, the structure for the
20 evaluation can be simplified.

Further, according to this embodiment, since the exposure time is automatically set to be short in accordance with the subject movement when it is determined that the correlation between frame images is low, image blur of a moving subject can
25 be prevented. When the subject movement is slow, since no image

blur is caused, shooting can be performed with the depth of field being large.

Further, according to this embodiment, the possibility can be minimized that the exposure time increases because of
5 low brightness to cause a camera shake.

Moreover, according to this embodiment, since the imaging section for images for recording (shooting) and the imaging section for producing image data for determining the correlation are common, it is unnecessary to separately provide
10 these imaging sections, so that cost and size reduction can be achieved.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted that various change and modifications will
15 be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as being included therein.

WHAT IS CLAIMED IS:

1. A digital camera comprising:

an image sensing unit for sensing a subject image;

5 a detector for detecting a degree of correlation between
image data of a plurality of frames from said image sensing unit
before shooting;

an exposure controller for, in a case where the degree
of correlation is low as a result of the detection by said
detector, controlling an exposure time of said image sensing
10 unit so as to be shorter than an exposure time in a case where
the degree of correlation is high; and

a recorder for recording image data from said image
sensing unit controlled by said exposure controller.

2. A digital camera according to claim 1, further
15 comprising a comparator for comparing a pixel level difference
between the images of a plurality frames with a predetermined
threshold value.

3. A digital camera according to claim 2, wherein said
detector detects the degree of correlation according to the
20 number of the pixels for which the same comparison result is
obtained.

4. A digital camera according to claim 3, wherein said
detector detects the degree of correlation according to the
ratio between the number of the pixels and a predetermined
25 number of pixels.

5. A digital camera according to claim 2, wherein said detector detects the degree of correlation according to the sum of the pixels for which the pixel level difference is not less than the predetermined threshold value.

5 6. A digital camera according to claim 5, wherein said detector detects the degree of correlation according to the ratio between the sum of the pixels and a predetermined number of pixels.

10 7. A digital camera according to claim 1, further comprising a display for displaying the image sensed by the image sensing unit before shooting,

 wherein said detector detects the degree of correlation from the image to be displayed by said display.

15 8. An exposure control method of a digital camera, comprising the steps of:

 sensing a subject image by an image sensing unit;

 detecting a degree of correlation between image data of a plurality of frames from said image sensing unit before shooting;

20 in a case where the degree of correlation is low as a result of the detection, controlling an exposure time of said image sensing unit so as to be shorter than an exposure time in a case where the degree of correlation is high; and

 recording image data from said controlled image sensing
25 unit.

9. A digital camera comprising:
an image sensing unit for sensing a subject image;
a detector for detecting a degree of correlation between
image data of a plurality of frames from said image sensing unit
5 before shooting;

a memory for storing a first program and a second program
to control an exposure time of said image sensing unit
respectively, wherein the exposure time based on the second
program is set to be shorter than the exposure time based on
10 the first program;

a selector for selecting the second program in the case
where the degree of correlation is lower than a predetermined
level; and

a recorder for recording image data from said image
15 sensing unit controlled based on the second program.

10. A digital camera according to claim 9, wherein said
selector selects the first program in the case where the
brightness of the subject is lower than a predetermined value.

11. An exposure control method of a digital camera,
20 comprising the steps of:

sensing a subject image by an image sensing unit;

detecting a degree of correlation between image data of
a plurality of frames from said image sensing unit before
shooting;

25 storing a first program and a second program to control

an exposure time of said image sensing unit respectively,
wherein the exposure time based on the second program is set
to be shorter than the exposure time based on the first program;

selecting the second program in the case where the degree
5 of correlation is lower than a predetermined level; and
recording image data from said image sensing unit
controlled based on the second program.

12. A digital camera comprising:

an image sensing unit for sensing a subject image;
10 a detector for detecting a degree of correlation between
image data of a plurality of frames from said image sensing unit
before shooting;

a memory for storing a first program and a second program
to control an aperture value of said image sensing unit
15 respectively, wherein the aperture value based on the second
program is set to be smaller than the aperture value based on
the first program;

a selector for selecting the second program in the case
where the degree of correlation is lower than a predetermined
20 level; and

a recorder for recording image data from said image
sensing unit controlled based on the second program.

13. A digital camera according to claim 12, wherein said
selector selects the first program in the case where the
25 brightness of the subject is lower than a predetermined value.

14. An exposure control method of a digital camera,
comprising the steps of:

sensing a subject image by an image sensing unit;

detecting a degree of correlation between image data of
5 a plurality of frames from said image sensing unit before
shooting;

storing a first program and a second program to control
an aperture value of said image sensing unit respectively,
wherein the aperture value based on the second program is set
10 to be smaller than the aperture value based on the first program;

selecting the second program in the case where the degree
of correlation is lower than a predetermined level; and

recording image data from said image sensing unit
controlled based on the second program.

ABSTRACT OF THE DISCLOSURE

Two subject images shot by an imaging section before real exposure are captured, and the difference between data is obtained for each corresponding pixels of the subject images by an interframe difference calculation section. The difference is compared with a threshold value by a threshold value comparison section, the pixels of levels not less than the threshold value level are extracted as a non-correlated portion, and the ratio of the area of the non-correlated portion to all the detected pixels is obtained by a non-correlated portion area calculation section. When the ratio of the area of the non-correlated portion is high, it is determined that the subject movement is large, so that a speed priority program line is selected by an exposure calculation block and the exposure time is set to be shorter than the normal exposure time, thereby preventing subject image blur.

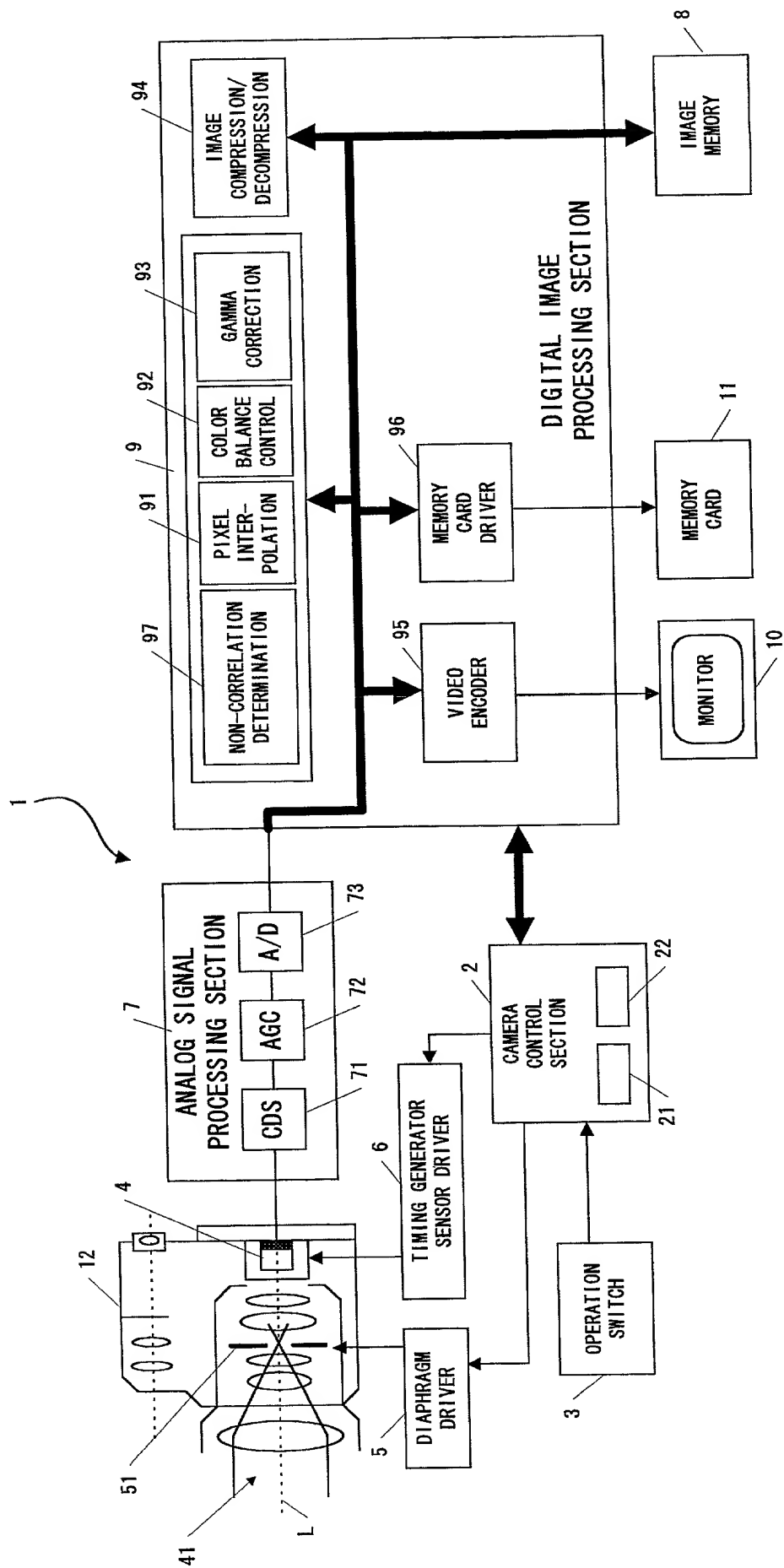
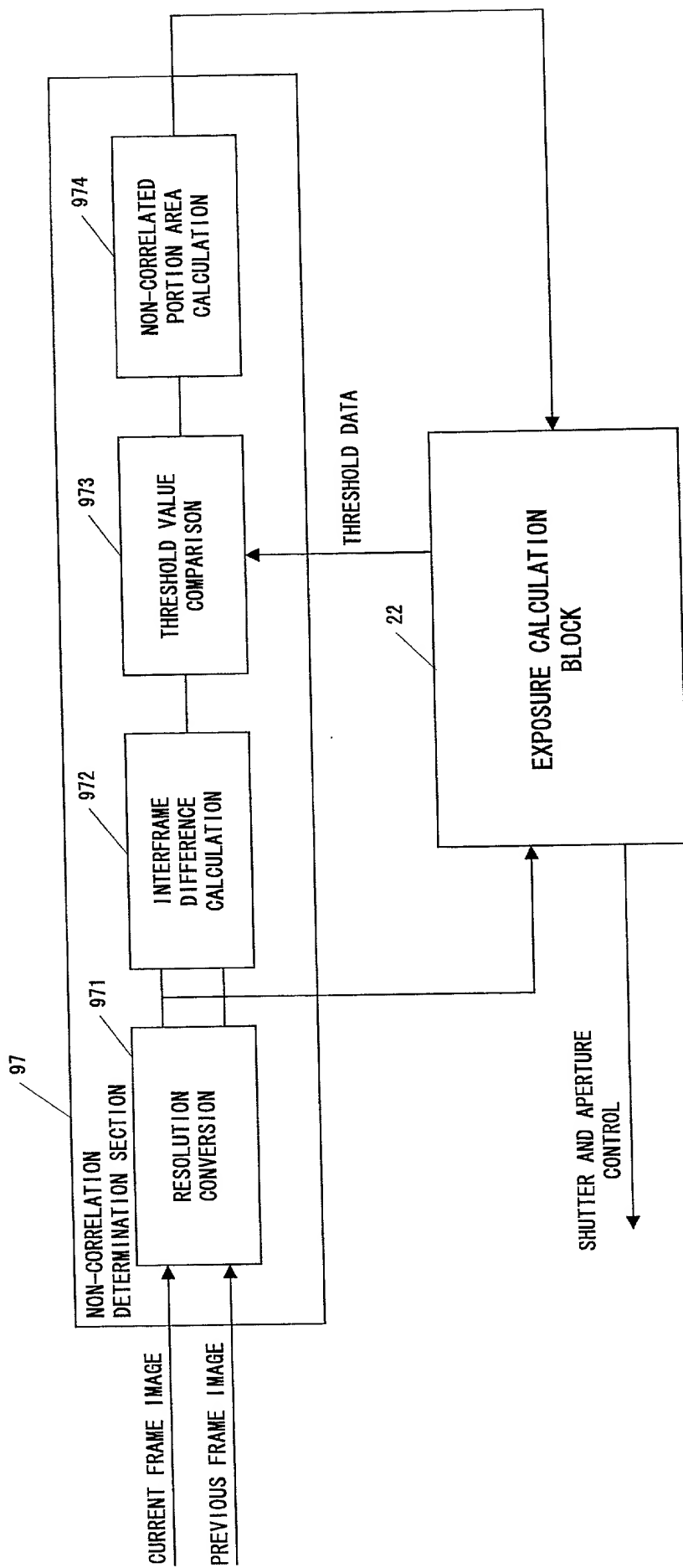


Fig. 1

Fig. 2



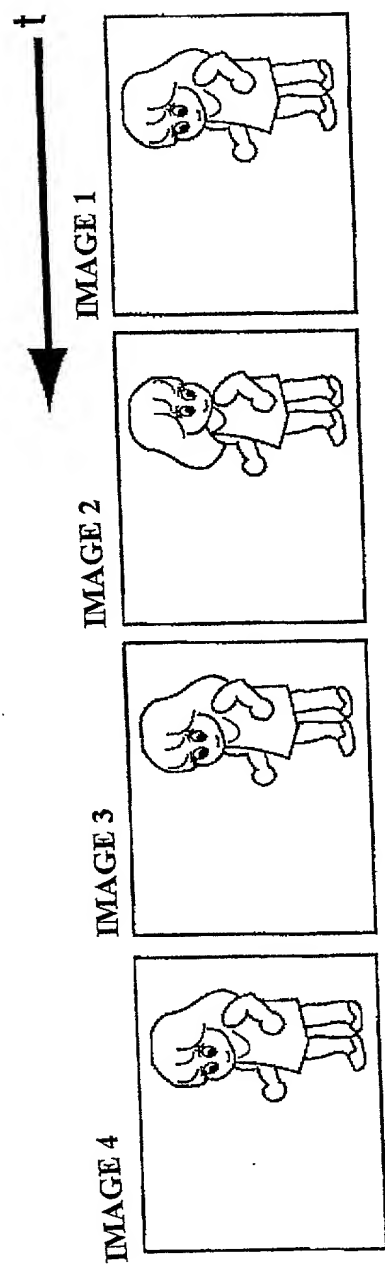


Fig. 3A

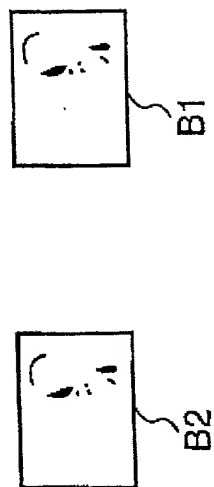


Fig. 3B

Fig. 4A

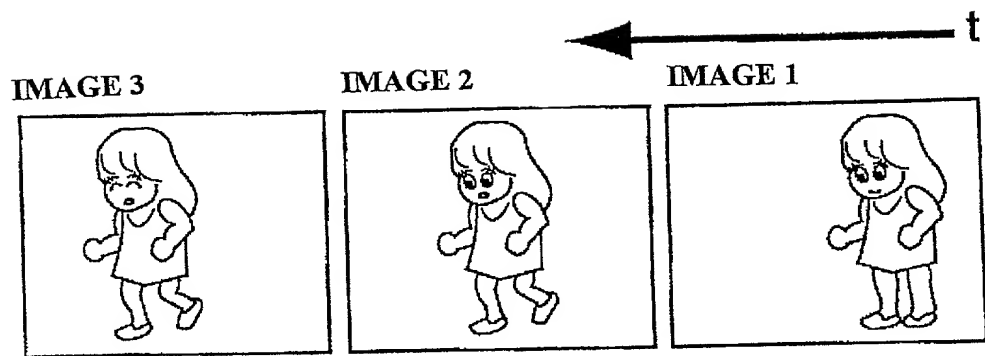


Fig. 4B



Fig. 4C



Fig. 5

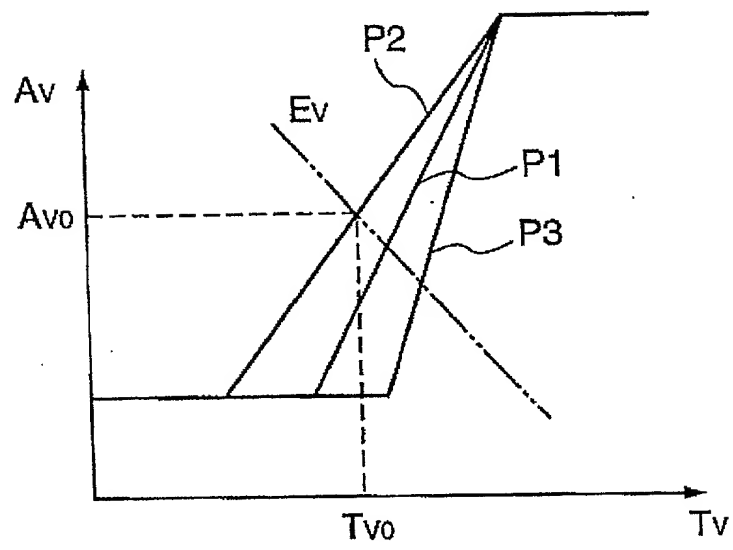


Fig. 6

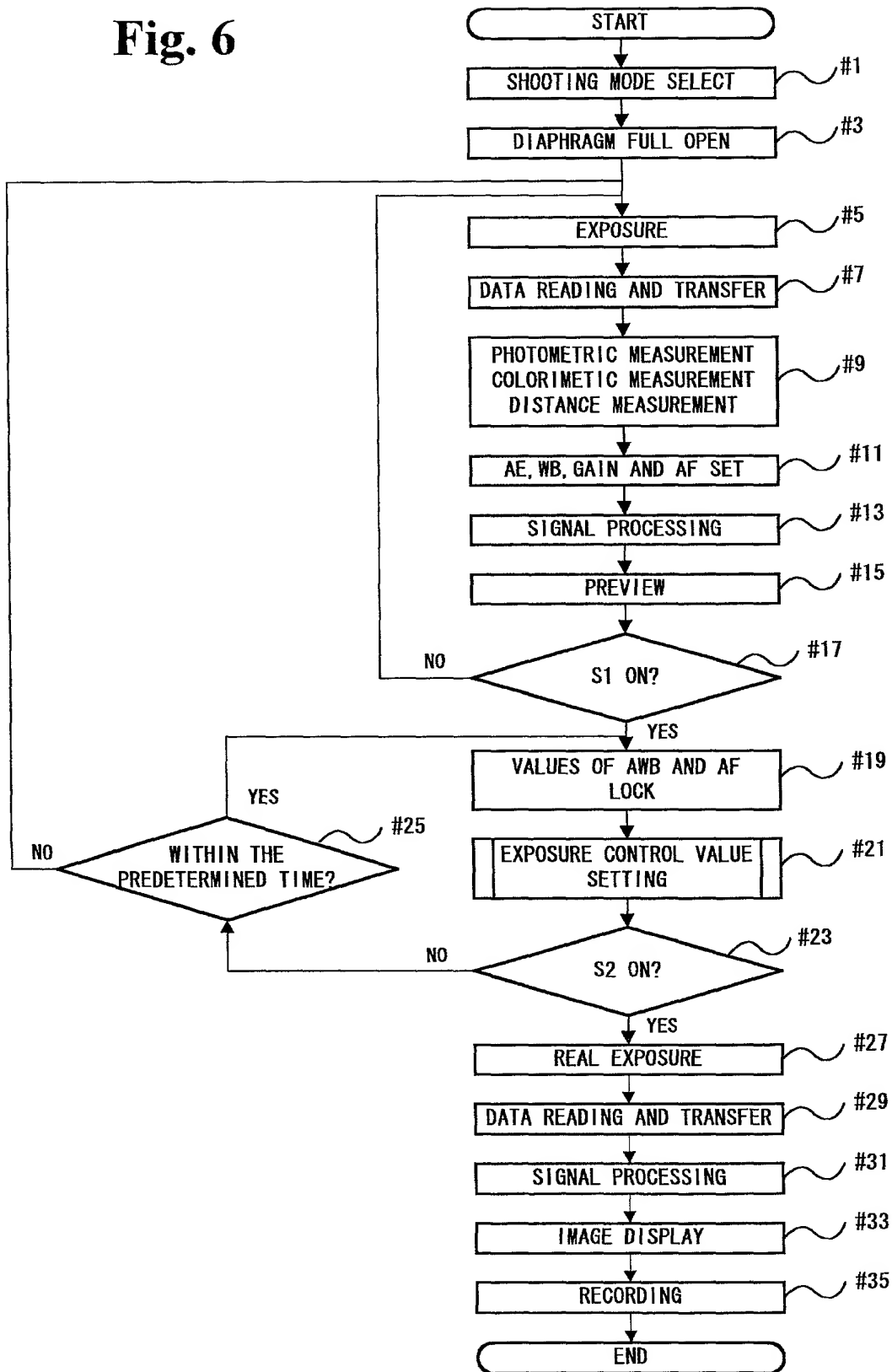


Fig. 7

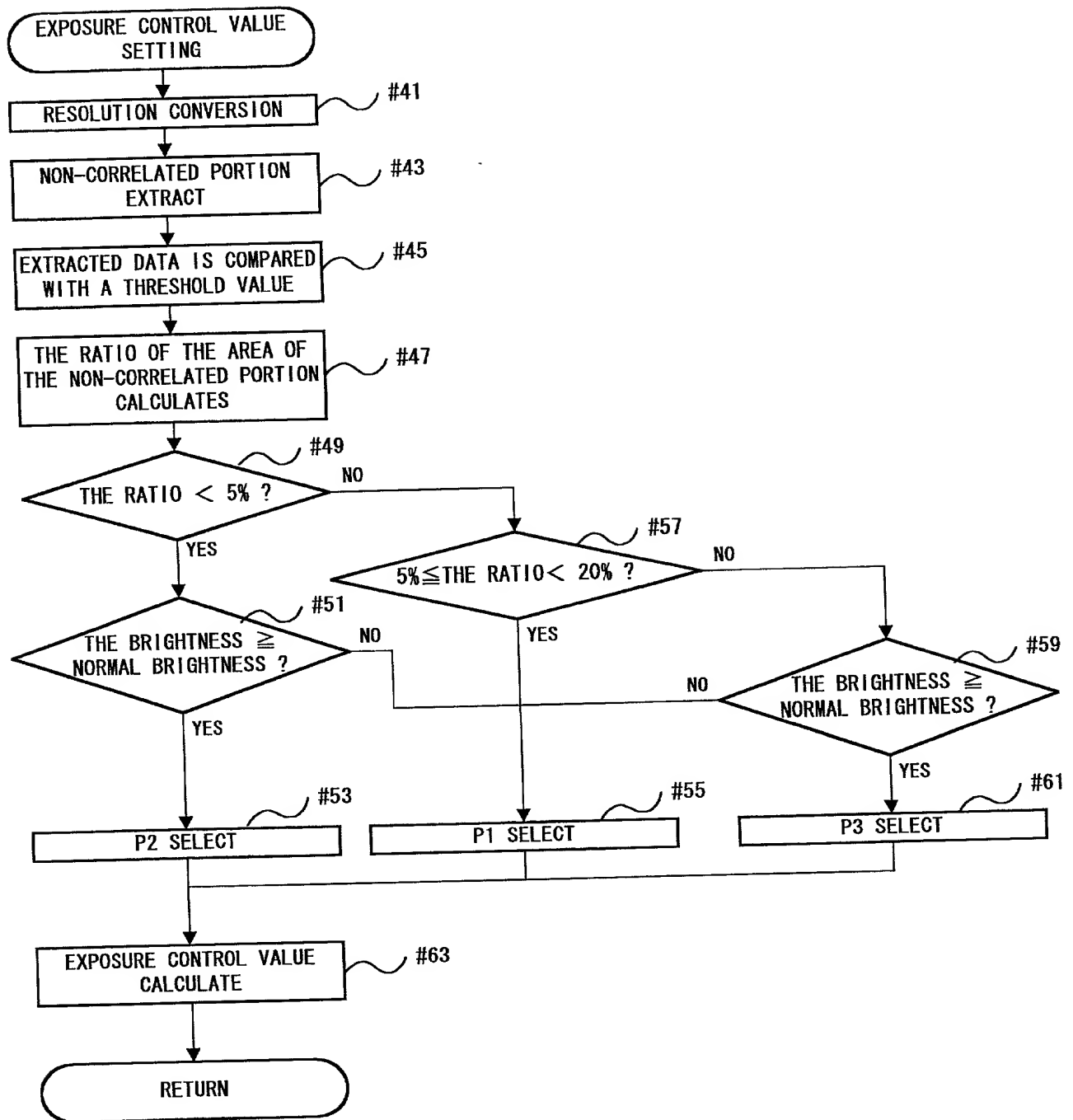


Fig. 8

THE RATIO OF THE NON-CORRELATED AREA	THE BRIGHTNESS OF THE SUBJECT	SELECTED PROGRAM CHARACTERISTIC		
		DEPTH PRIORITY PROGRAM	STANDARD PROGRAM	SPEED PRIORITY PROGRAM
LESS THAN 5%	NORMAL BRIGHTNESS	○		
	LOW BRIGHTNESS		○	
NOT LESS THAN 5%	NORMAL BRIGHTNESS		○	
	LOW BRIGHTNESS		○	
NOT LESS THAN 20%	NORMAL BRIGHTNESS			○
	LOW BRIGHTNESS		○	

代理人の案件番号:

Attorney Docket No.:

特許出願宣誓書および委任状

**DECLARATION AND POWER OF
ATTORNEY FOR PATENT APPLICATION**

私は、以下に記載された発明者として、こ
こに下記の通り宣言する:

As a below named inventor, I hereby declare
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の後に記載された通りである。

My residence, post office address, and
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下記の名称の発明について、特許請求の範
囲に記載され、かつ特許が求められている発
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ている場合）か、または、私と以下に記載さ
れた他の者が最初、最先かつ共同発明者であ
る（複数の氏名が記載されている場合）と、
信じている。

I believe that I am the original, first, and sole
inventor (if only one name is listed below) or I
and the other person(s) listed below are the
original, first, and joint inventors (if plural names
are listed below) of the subject matter which is
claimed and for which a patent is sought on the
invention entitled

DIGITAL CAMERA AND

EXPOSURE CONTROL METHOD OF DIGITAL CAMERA

上記発明の明細書はここに添付されている
が、下記のボックスがチェックされている場
合は、この限りでない:

the specification of which is attached hereto
unless the following box is checked:

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☐ was filed on

以下の米国出願番号を有し、

as United States Application Number

または、以下のPCT国際出願番号を有し、

or PCT International Application Number

かつ、以下の日に補正されている

and was amended on

(該当する場合)。

(if applicable).

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特許請求の範囲を含む上記明細書を検討し、
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I hereby state that I have reviewed and
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specification, including the claims, as amended
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に定義されている、特許性について重要な情
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I acknowledge the duty to disclose
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Section 1.56.

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許出願または発明者証の出願、或いは米国以
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願について、同第119条(a)-(d)項または第3
65条(b)項に基づいて優先権を主張するとと
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ついては、いかなる出願も、下記のボックス
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I hereby claim foreign priority under Title
35, United States Code, Section 119(a)-(d) or
365(b) of any foreign application(s) for patent or
inventor's certificate, or 365(a) of any PCT
international application which designated at
least one country other than the United States
listed below and have also identified below, by
checking the box, any foreign application for
patent or inventor's certificate, or PCT
international application having a filing date
before that of the application on which priority is
claimed.

PRIOR FOREIGN APPLICATION(S)
(外国での先行出願)

Priority
Not Claimed
(優先権主張なし)

11-274400 (Number) (番号)	Japan (Country) (国名)	28 / 9 / 1999 (Day/Month/Year Filed) (出願日/月/年)
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)
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(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)

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私は、ここに、下記のいかなる米国仮特許
出願についても、その米国法典第 35 編 11
9 条(e)項の利益を主張する。

I hereby claim the benefit under Title 35,
United States Code, Section 119(e) of any United
States provisional application(s) listed below.

(Application Number)
(出願番号)

(Filing Date)
(出願日)

(Application Number)
(出願番号)

(Filing Date)
(出願日)

1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755 2756 2757 2758 2759 2760 2761 2762 2763 2

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application Number) (Filing Date)
(出願番号) (出願日)

(Status: Patented, Pending, Abandoned)
(現狀: 特許許可、係屬中、放棄)

(Status: Patented, Pending, Abandoned)
(現狀：特許許可、係屬中、放棄)

(Application Number)	(Filing Date)
(出願番号)	(出願日)

(Status: Patented, Pending, Abandoned)
(現狀：特許許可、係屬中、放棄)

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(現狀：特許許可、係屬中、放棄)

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Customer Number: 24367

直通電話先:

James W. Williams

ダイレクトイン: (214) 981-3328

代表電話番号: (214) 981-3300

代理人の案件番号: _____

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the practitioners associated with the Customer Number provided below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number.



24367

PATENT & TRADEMARK OFFICE

Direct telephone calls to:

James W. Williams

Direct No.: (214) 981-3328

Main No.: (214) 981-3300

Attorney Docket No.: _____

Full name of sole or first joint inventor:

唯一または第 1 発明者の氏名:

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First	Middle	Last
(名)	(ミドルネーム)	(姓)

Inventor's signature: Hiroaki Kubo
発明者の署名:

Date: Sep 18, 2000
日付:

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住所:	(City)	(Prefecture)	(Country)
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